Analysis of the existing constraints of the “sports season teaching model” in physical education in colleges and universities

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Abstract

The analysis of the existing constraints of “sports season teaching mode” is of great significance to the reform of physical education in colleges and universities. In this paper, the model structure and method steps of the hierarchical analysis method are studied, and FHAP with a fuzzy set is proposed for the defects of the consistency test of the judgment matrix. Finally, the weights of each constraint factor are calculated by fuzzy matrix. In the dimension of hardware teaching environment, the importance ratings of “sports venue” relative to other factors are 0.26, 0.74, 0.87, 0.64 and 0.86, and the top three constraints are “sports facilities”, “sports venue,” and “sports facilities”. The top three constraints were “sports facilities”, “sports venues”, and “student-teacher ratio”. Based on FAHP, the key constraints can be analyzed from qualitative and quantitative perspectives, which can provide a scientific and effective reference for developing the teaching mode of the college sports season. The FAHP study analyzed the key constraints from qualitative and quantitative perspectives, which can provide scientific reference for developing the college sports season teaching model.

Keywords: FAHP; Sport season teaching; Constraints; Judgment matrix; Hierarchical indicator set
AMS 2020 codes: 97U99
1 Introduction

At present, college physical education is still a relatively weak link in the whole educational undertaking, and there still exist in college physical education at present such as physical education classes and extracurricular activities time cannot be guaranteed, and students’ physical health level is still the obvious short board of students’ quality [1-2]. In this regard, the state put forward four principles to promote the reform and development of college physical education, namely, insisting on linking classroom teaching and extracurricular activities, promoting cultivating interest and improving skills, coordinating mass sports and sports competition, and combining comprehensive promotion and classification guidance [3-4]. However, it is noteworthy that the effective connection between classroom teaching and extracurricular activities and the organic combination of sports competition and physical education have been the problems that have not been solved in college physical education [5-6].

The sport season teaching model is guided by the theory of sports education derived from game theory. It is based on direct teacher guidance, cooperative and partner learning as the learning method, fixed grouping, role-playing as the organizational form, and competition as the main line in the teaching process [7-8]. The sport season teaching model can provide students of different levels with authentic and rich sports experiences [9]. The sports season instructional model contains six major elements: season, team affiliation, formal competition, record keeping, post-season celebration, and holiday fun.

Movement education, represented by the movement season teaching model, has received attention from researchers in various countries. The literature [10] compared the effects of the sports education model and traditional styles on self-competence motivation and implicit beliefs and concluded that the sports education model is the best choice to promote students’ self-motivation. The literature [11] designed an experiment to study the effect of the movement education model in teaching basketball in higher education institutions and proved through empirical studies that the movement education model could significantly improve students’ physical fitness. The literature [12] designed an experimental group using the movement education model and a control group using the direct instruction model to study the effects of these two physical education models on students’ learning attitudes and proved that there were significant differences between the two in the dimensions of students’ interest, perceived competence, value, effort and perception.

The literature [13], on the other hand, analyzed the effect of applying the movement education model in physical education classes on the emotional domain of physical education college students through a follow-up study of 10 college students, and the results showed that the movement education model helped college students to strengthen multiple characteristics in the emotional domain. Using literature, questionnaires, experiments, mathematical statistics and comparative analysis, the literature [14] conducted an experimental pedagogical study on high school soccer teaching and suggested that the movement education model could improve students’ core qualities. The literature [15] argued that the movement education model plays an active role in physical education in colleges and universities and is important for cultivating comprehensive and interdisciplinary talents and proposed a teaching method that combines the movement education model with catechism. The literature [16] conducted a ten-week teaching of the physical education model to high school students in Ninghai Middle School, and the results showed that the student’s learning interest and degree of physical education awareness significantly increased, and the movement education model is worthy of reference in physical education teaching.

In this paper, we first establish a hierarchical structure model based on the idea of the hierarchical analysis method, study the meaning of different scales in the judgment matrix under the Santy scale, and test its consistency by calculating the test index through column vector normalization operation.
for single sort and total sort of the layers respectively. Secondly, to address the problems of AHP, such as the large workload of calculation and adjustment and the lack of objectivity in the consistency of the judgment matrix, the fuzzy set theory is used for optimization, and the weights of each constraint in the fuzzy matrix are calculated by constructing the judgment matrix of each layer method compared with the previous layer, and then the fuzzy complementary judgment matrix is obtained through complementary adjustment. Then, the advantages of sports season teaching mode and traditional physical education teaching are compared, and the teaching objectives and methods of sports season teaching mode are studied. Finally, a hierarchical index set of constraints of the sports season teaching mode is established based on FAHP, and the importance of each constraint in each tier is rated, and finally, the weights of the upper tier indexes and the progressive weights of the lower tier indexes are derived.

2 Fuzzy hierarchical analysis method

2.1 Hierarchical analysis method

Hierarchical analysis (AHP) is a system analysis method combining qualitative and quantitative analysis proposed by an American operations researcher, Professor A.L. Saaty, of the University of Pittsburgh. Its analysis process is divided into five stages: specifying the problem, building a hierarchical analysis structural model, constructing a judgment matrix, single hierarchical ranking, and hierarchical total ranking [17]. The hierarchical analysis method can provide a comprehensive evaluation value reference basis for selecting the optimal solution.

2.1.1 Building a hierarchical model

When analyzing a problem with hierarchical analysis, the problem is first hierarchized. According to the nature of the problem and the overall objective, the problem is decomposed into different component factors, and the factors are aggregated and combined at different levels according to the interrelated influence and affiliation between the factors to form a multi-level analysis structure model. Each level has several factors, and the relative importance of the factors in each level is judged by a two-by-two comparison to determine the relative weight value of each factor on the target level, and finally, the problem is reduced to the determination of the relative importance weight value of the lowest level relative to the highest level or the ranking of the relative advantages and disadvantages. The structural model of hierarchical analysis is shown in Figure 1. A good hierarchical model is very important for problem-solving. The objective of the decision, the factors to be considered (decision criteria) and the decision object are divided into objective level, criterion level, sub-criteria level (if any) and solution level according to their interrelationship, and the hierarchical structure is drawn.
2.1.2 Constructing the judgment matrix

After establishing the hierarchical analysis structure model, when determining the weights among the factors at each level, a relative scale is used to compare the factors two by two with each other and construct a comparative judgment matrix to minimize the difficulty of comparing factors of different nature with each other and improve the accuracy.

The Santy scale was introduced to obtain a quantitative judgment matrix by two-by-two comparison between each factor $c_{ij}$. The Santy scale assignment and meaning are shown in Table 1.

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The two factors are equally important compared to each other.</td>
</tr>
<tr>
<td>3</td>
<td>Compared to the two factors, one factor is slightly more important than the other.</td>
</tr>
<tr>
<td>5</td>
<td>Compared to the two factors, one factor is significantly more important than the other.</td>
</tr>
<tr>
<td>7</td>
<td>Compared to two factors, one factor is strongly more important than the other.</td>
</tr>
<tr>
<td>9</td>
<td>Compared to the two factors, one factor is extremely important than the other.</td>
</tr>
<tr>
<td>2,4,6,8</td>
<td>The median of the above two adjacent judgments</td>
</tr>
<tr>
<td>Reciprocal</td>
<td>If the comparison of factors $i$ and $j$ is judged as $c_{ij}$, then the judgment of factor $j$ and $i$ comparison is $c_{ji} = 1 / c_{ij}$.</td>
</tr>
</tbody>
</table>

After building the analytical structural model, the relative importance of the factors in each stratum needs to be assigned with a judgment on the scale. In general, for criterion $B_k$ of the upper level, each factor of the lower level is compared with its related factor. The relative importance of factor $C_j$ and factor $C_j$ with respect to criterion $B_k$ in the upper level constitutes a judgment matrix. For $n$ factors, we obtain a two-by-two comparison judgment matrix $C = (C_{ij})_{n \times n}$. The form of judgment
matrix $C = (C_{ij})_{n \times n}$ is shown in Table 2, where $c_{ij} = \frac{1}{c_{ji}}$ ($i \neq j$), and $c_{ij} > 0$. The weight vector of $C_1, C_2, \ldots, C_n$ to $B_k$ is determined by matrix $C$.

<table>
<thead>
<tr>
<th>$B_k$</th>
<th>$C_1$</th>
<th>$C_2$</th>
<th>...</th>
<th>$C_n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1$</td>
<td>$c_{11}$</td>
<td>$c_{12}$</td>
<td>...</td>
<td>$c_{1n}$</td>
</tr>
<tr>
<td>$C_2$</td>
<td>$c_{21}$</td>
<td>$c_{22}$</td>
<td>...</td>
<td>$c_{2n}$</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>$C_n$</td>
<td>$c_{n1}$</td>
<td>$c_{n2}$</td>
<td>...</td>
<td>$c_{nn}$</td>
</tr>
</tbody>
</table>

### 2.1.3 Hierarchical single ranking and one-time test

Hierarchical single ranking means that after the judgment matrix is constructed, the weights of the relative order of importance of the factors of this level to the associated factors of the previous level are obtained based on the judgment matrix using mathematical methods of quantitative calculation. The problem of hierarchical single-level calculation can be reduced to the problem of calculating the maximum characteristic roots of the judgment matrix and its eigenvectors. The exact calculation in the strict sense requires the use of power calculation, which is a very complicated and tedious process, while in general, the maximum eigenvalues of the judgment matrix and the corresponding eigenvectors do not require a high degree of accuracy and can simplify the calculation.

First, the $C$ factor is normalized by column vector, and the $C$ factor is summed by row, and again the row and vector are normalized to obtain the ranking weight vector, denoted by $W$. Finally, the maximum eigenvalue is calculated by the following formula:

$$\lambda_{max} = \sum_{i=1}^{n} \frac{(CW)_i}{nW_i}$$

(1)

Where $(CW)_i$ denotes the $i$th factor of $CW$.

The ability to confirm the hierarchical order requires a consistency test. By consistency test, we mean to determine the allowable range of inconsistency for $C$. The consistency test starts with the calculation of the consistency index $CI$. The calculation formula is:

$$CI = \frac{\lambda_{max} - n}{n-1}$$

(2)

Where $\lambda_{max}$ is the maximum eigenvalue of the judgment matrix and $n$ is the order of the comparison matrix. $CI = 0$ indicates that there is complete consistency. $CI$ is close to 0 indicates that there is satisfactory agreement. $CI$ the larger, the more serious the inconsistency.

When the order $n$ is greater than 2, the random consistency index $RI$ is introduced to measure the size of $CI$. The ratio of the consistency index $CI$ of the judgment matrix to the random consistency index $RI$ of the same order is called the random consistency ratio $CR$. When $CR = \frac{CI}{RI} < 0.10$, the
degree of inconsistency of the judgment matrix $C$ is considered to be within the permissible range and has satisfactory consistency, and it passes the consistency test, and its normalized feature vector can be used as the weight vector. Otherwise, it is necessary to adjust the judgment matrix.

### 2.1.4 Hierarchical total ranking and one-time test

The first layer $B$ under the total objective layer $A$ has $n$ factors $B_1, B_2, \ldots, B_n$ with ranking $b_1, b_2, \ldots, b_n$ to the total objective $A$. The second layer $C$ has $m$ factors with hierarchical single ranking $c_{1j}, c_{2j}, \ldots, c_{mj} (j = 1, 2, \ldots, n)$ to the factor $B_j$ in the upper layer $B$. Then the total ranking of the layers of $C$ is shown in Table 3. The weight of the $i$th factor in the $C$th level on the total objective is:

$$W_c = \sum_{j=1}^{n} b_j c_{ij}$$  \hspace{1cm} (3)

<table>
<thead>
<tr>
<th>Layer</th>
<th>The total ranking of the hierarchy of the $C$ layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1$</td>
<td>$C_{11} C_{12} \cdots C_{1n}$</td>
</tr>
<tr>
<td>$C_2$</td>
<td>$C_{21} C_{22} \cdots C_{2n}$</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>$C_m$</td>
<td>$C_{m1} C_{m2} \cdots C_{mn}$</td>
</tr>
</tbody>
</table>

Let the consistency test index of hierarchical single ranking of factors in layer $C$ to upper layer $B$ be $CI_i$ and the random consistency index be $RI_i$, then the consistency ratio of hierarchical total ranking is:

$$CR = \frac{c_1 CI_1 + c_2 CI_2 + \cdots + c_n CI_n}{c_1 RI_1 + c_2 RI_2 + \cdots + c_n RI_n}$$  \hspace{1cm} (4)

When $CR < 0.1$, the hierarchical total ordering passes the consistency test and the hierarchical total ordering has satisfactory consistency. Otherwise, the elements of those judgment matrices with high consistency ratio need to be readjusted to take values.

### 2.2 Fuzzy hierarchical analysis

Although AHP can quantify evaluation indexes, it has been widely used. However, it has shortcomings in the consistency test of the judgment matrix, and at this stage, the consistency test of the judgment matrix faces the following challenges:

1) The workload of exact calculation and adjustment of the matrix is large.

2) The judgment criteria lack scientific basis.
3) The consistency of the judgment matrix is significantly different from the consistency of human thinking.

For this reason, it is combined with the fuzzy evaluation method to apply to the study of practical problems, and fuzzy hierarchical analysis (FAHP) that incorporates fuzzy sets is proposed.

The FAHP approach requires the identification of a suitable decision problem as the target problem to be analyzed from the perspective of deciding on the target decision problem. The problem must contain multiple influencing factors to analyze the composition of the influencing factors of the target problem and thus determine the linkages between the factors. Secondly, based on the constituent units of each decision influencing factor, a multi-level structural model of this decision problem is determined to facilitate the decision maker to determine the weights of each influencing factor. Then a fuzzy judgment matrix needs to be constructed, which determines the relative weights by comparing them with each other, thus determining the weight ranking of each influence factor in the overall model. According to the constructed judgment matrix, the weights of each influence factor in the same layer are determined and then integrated into calculating the specific weights of each influence factor in the model. Finally, the iterative precision of the index weights is carried out through the inverse comparison matrix, and the final convergence result is obtained by judging whether the error of the iterative weights meets the accuracy requirement of the iteration termination condition and then whether the judgment matrix needs to be adjusted by further iterations until the termination condition is met.

![Figure 2. Analysis steps of FAHP](image-url)
2.2.1 Construction of fuzzy complementary judgment matrix

A judgment matrix in hierarchical analysis refers to the relative importance of the elements in each level relative to an element in the previous level through the form of a matrix, a matrix that measures the relative relationship between two elements, the physical meaning of the elements is the importance of the elements in the horizontal row relative to the elements in the vertical row. The judgment matrix is for each level in the hierarchical structure. That is, there is a judgment matrix for each level. As long as different indicators are of the same level, there is a judgment matrix so that the weights can be divided down layer by layer, the same to meet the requirements of consistency testing. And the matrix established in the fuzzy hierarchical analysis method is called the fuzzy consistency judgment matrix.

If matrix \( R = (r_{ij})_{n \times n} \) satisfies:

\[
0 \leq r_{ij} \leq 1(i = 1, 2, \ldots, n; j = 1, 2, \ldots, n)
\]

Then it is called a fuzzy matrix.

If matrix \( R = (r_{ij})_{n \times n} \) satisfies:

\[
r_{ij} + r_{ji} = 1(i = 1, 2, \ldots, n; j = 1, 2, \ldots, n)
\]

Then it is called a fuzzy complementary matrix.

If the fuzzy complementary matrix \( R = (r_{ij})_{n \times n} \) satisfies:

\[
\forall i, j, k, r_{ij} = r_{ik} - r_{jk} + 0.5
\]

Then it is said to be consistent.

This yields the property of fuzzy consistent matrices: Fuzzy consistent matrices are all complimentary.

A fuzzy matrix is defined in fuzzy mathematics as a matrix representation of fuzzy relations for judging the relative importance of solutions at the same level. For the hierarchy, the judgment is made using the method of two-by-two comparison, and the judgment matrix is constructed for each layer of methods compared with the previous layer, called the fuzzy judgment matrix. Suppose that \( n \) elements of a scheme layer \( C \) are subschemes of scheme \( A \) of the previous layer, then the fuzzy judgment matrix constructed about the subschemes of scheme layer \( A \) is a matrix of \( (n+1) \times (n+1) \).

The fuzzy matrix can be used to obtain the ranking of the influence of \( n \) subprograms on scheme layer \( A \). The importance of the subprograms can be obtained by the expert method.

To delineate the relative importance among the influencing factors using careful numerical values, this paper uses the 0.1-0.9 scale method to quantitatively express the relative importance of any two elements. This scaling method expresses the relative importance among factors in terms of specific values, and each relative comparison interval can be divided into four subintervals, which indicate four different levels of importance.

According to the numerical scale of the scalar method, the fuzzy complementary judgment matrix of element \( a_1, a_2, \ldots, a_n \) in a certain level compared with each other is shown in the following equation:
2.2.2 Calculation of the weights of the fuzzy matrix

Regarding the weight calculation of the judgment matrix, there are many different methods in academia, and this paper adopts the deduced weight calculation method with the formula:

\[ w_i = \frac{\sum_{j=1}^{n} a_{ij} + \frac{n-1}{2}}{n(n-1)}, (i = 1, 2, 3, \cdots n) \]  

(9)

The formula effectively uses the good features and judgment information of the consistency judgment matrix with a small amount of calculation.

From this, the weight vector of fuzzy judgment matrix \( A \) can be obtained:

\[ W = (w_1, w_2, \cdots, w_n)^T \]  

(10)

2.2.3 Fuzzy matrix consistency test

To determine the reasonableness of the results of the weight calculation of the fuzzy judgment matrix, to analyze the consistency problem of the weight calculation of the fuzzy matrix, i.e., the results of the comparison of solutions, with the decision-making process of the decision-maker, and to avoid the contradiction between the importance of the indicators, it is necessary to perform a consistency test on the fuzzy matrix.

The full compatibility of the fuzzy complementary judgment matrix \( A \) with its feature matrix \( W \) is equivalent to its own full consistency, so the consistency problem can be judged by studying the compatibility of the fuzzy complementary judgment matrix \( A \) with its feature matrix \( W \).

\( A \) is a sufficient necessary condition for a fully consistent fuzzy complementary judgment matrix of \( I(A, W^*) = 0 \).

For the inconsistent fuzzy judgment matrix, its consistency index \( I(A, W^*) = 0 > 0 \), and the larger \( I(A, W^*) = 0 \) is, the worse the consistency degree of \( A \) is. In practical application, a critical value \( \varepsilon \) can be taken so that \( I(A, W^*) < \varepsilon \) is considered to have satisfactory consistency.

If \( I(A, W^*) \leq 0.1 \), then the fuzzy complementary matrix is judged to satisfy the consistency:

\[ I(A, W^*) = \frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} |a_{ij} + w_{ji} - 1| \]  

(11)
where is the characteristic matrix of the fuzzy judgment matrix:

\[
W^* = \left( W_{ij} \right)_{n \times n}
\]

(12)

And:

\[
W_{ij} = \left( w_{ij} \right)_{n \times n}
\]

(13)

Therefore:

\[
w_{ij} = \frac{w_i}{w_i + w_j} (i, j = 1, 2, 3, \ldots, n)
\]

(14)

The hierarchical total ranking of the influencing factors is performed by up and down correspondence. Assume that the total objective level is \( A \), the criterion level is \( B \), and the factor level is \( C \). Then the weight of \( B \) within \( A \) is denoted as \( a_1, a_2, \ldots, a_m \) and the corresponding weight of \( C \) within \( B \) is denoted as \( b_1, b_2, \ldots, b_n \). Then the hierarchical single ranking weight of \( C \) to \( A \) is calculated as:

\[
b_j = \sum_{k=1}^{m} a_k b_j (j = 1, 2, \ldots, m)
\]

(15)

3 Sports season teaching model

3.1 Advantages of introducing sports season into physical education

In the 1990s, American physical education scholars introduced the concept of “sports seasons” into physical education. A season is usually composed of a practice period, a pre-season period, an official game period, and a post-season period with a final game, and it should be at least 20 sessions long. A sports season usually includes a pre-season, competition and final period, and the activity unit is two to three times longer than the activity unit of a traditional physical education class. This arrangement provides students with a deeper knowledge and understanding of a competitive sport and the opportunity to become finely tuned in their athletic experience. In the sports education model, all seasons are similar to those used in competitive sports, providing a way to organize and manage all events. Table 4 summarizes the advantages of the sports season over traditional physical education.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Specific role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Philosophy</td>
<td>It is conducive to better integrating physical education into the real competition situation and better reflecting the concept of life-oriented education.</td>
</tr>
<tr>
<td>Instructional management</td>
<td>The sports season becomes the center of organization and management, and the learning content is not only sports knowledge in the traditional sense but also includes the organization and management of sports competitions.</td>
</tr>
<tr>
<td>Teaching organization</td>
<td>It enables teachers to more clearly divide the teaching stages, connect teaching units or teaching modules, and enrich the module connotation in the new course standard.</td>
</tr>
</tbody>
</table>
3.2 Teaching Objectives of the Campaign Season Teaching Model

Teaching the sports season model aims to make students athletically competent, literate and enthusiastic athletes.

1) Sport competence goals include: developing sport-specific techniques, demonstrating sport-specific strategies, and developing knowledge and skills in officiating accreditation and training.

2) Sports literacy goals include: acting as a responsible leader, working efficiently according to team goals, and understanding and appreciating sports rituals and customs.

3) Sports enthusiasm goals include the desire to participate in sports, participate in off-campus sports activities, and share sports management and programming.

The aims and objectives of the sports season teaching model are largely aligned with the overall national requirements and very much aligned with core physical education and health literacy.

3.3 Teaching methods of the sports season teaching model

The teaching methods used in the sports season teaching model include the direct instruction method, cooperative learning method, partner learning method, contextual teaching method, competition method, etc. These methods form a very complete and effective teaching method system. The common teaching methods are shown in Table 5.

<table>
<thead>
<tr>
<th>Methods</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct guidance</td>
<td>Teachers face students directly to guide and improve students’ motor skills and problems that arise in team games.</td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>How students work together to achieve their teaching goals, improve motor skills, consolidate motor skills, and achieve mutual progress through cooperation.</td>
</tr>
<tr>
<td>Partnership learning</td>
<td>Have students serve as coaches to guide teammates in learning methods to improve their sports technical skills, and student coaches are students with higher technical skills.</td>
</tr>
<tr>
<td>Contextual learning</td>
<td>The learning method of simulating real competition situations in teaching, creating a real competition atmosphere for students, and integrating in-class learning with extracurricular competition activities.</td>
</tr>
<tr>
<td>Competition</td>
<td>According to students’ development level at different teaching stages, games and competitions suitable for students’ development levels are created according to the principle of progressiveness.</td>
</tr>
</tbody>
</table>

The proportion of the above five teaching methods and the emphasis on them differ in each teaching stage. In the beginning stage, the teacher’s direct instruction is the focus, and students’ cooperative learning is the supplement. However, as the learning progresses, there is a gradual transition to cooperative learning and partner learning, and the proportion of time spent on classroom teaching is also increasing.

4 FAHP-based analysis of sport season teaching constraints

After studying the teaching objectives and methods of the sports season teaching model, this paper establishes the hierarchical factors that constrain the sports season teaching based on fuzzy hierarchical analysis and analyzes the influence weights of different factors. The hierarchical index set of constraints based on FAHP is shown in Table 6.
Table 6. Indicators of constraint hierarchy

<table>
<thead>
<tr>
<th>Primary indicators</th>
<th>Secondary indicators</th>
<th>Tertiary indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical education hardware environment</td>
<td>External conditions</td>
<td>Sports venues (H1)</td>
</tr>
<tr>
<td></td>
<td>Internal conditions</td>
<td>Sports facilities (H2)</td>
</tr>
<tr>
<td></td>
<td>Organizational leadership</td>
<td>Multimedia (H3)</td>
</tr>
<tr>
<td></td>
<td>Teaching format</td>
<td>Sports periodicals, textbooks (H4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teacher-student ratio (H5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Class size (H6)</td>
</tr>
<tr>
<td>Physical education software environment</td>
<td>Organizational leadership</td>
<td>Leadership values (S1)</td>
</tr>
<tr>
<td></td>
<td>Teaching format</td>
<td>Class cohesion (S2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cooperation between students (S3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The mood of the student in the class (S4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Student differences (S5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students’ attitude towards learning (S6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Student sports interests (S7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The teacher’s teaching attitude (S8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The level of teaching of the teacher (S9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Classroom atmosphere (S10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teacher-student relationship (S11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical education teaching concept (S12)</td>
</tr>
</tbody>
</table>

4.1 Analysis of FAHP-based hardware teaching environment

The 0.1-0.9 scale shows the importance scores of each indicator in the hardware teaching environment index layer in Figure 3. Comparing the importance of different constraints, the importance scores of “physical education facilities” relative to other factors are 0.26, 0.74, 0.87, 0.64 and 0.86, which means that “physical education facilities” is significantly more important than “physical education facilities”, and “physical education facilities” is significantly more important than “multimedia facilities”. Sports facilities” is significantly more important than “sports venues”, “sports venues” is significantly more important than “multimedia facilities”, especially important than “sports periodicals “sports facilities” is significantly more important than “sports venues”, “sports venues” is significantly more important than “multimedia facilities”, “sports periodicals” is particularly important, “student-teacher ratio” is slightly more important, and “class size” is particularly important. The importance of any two different constraints can be compared based on the same importance scale. After consistency transformation and hierarchical ranking, we can get the ranking of the weight of the influencing factors governing the sports season in the hardware teaching environment in the order of physical education facilities, physical education venues, teacher-student ratio, multimedia facilities, class size, and physical education journals, with the weights of 0.24, 0.22, 0.2, 0.19, 0.08, and 0.06, respectively.
4.2 Analysis of FAHP-based software teaching environment

4.2.1 Organizational leadership indicator layer analysis

The importance scores of each constraint at the organizational leadership indicator level are shown in Figure 4. Comparing the importance of different constraints, the importance scores of “leadership importance” versus “class cohesion”, “cooperation among students”, “students’ mood in class”, “students’ differences”, and “students’ learning attitudes” are 0.53, 0.24, and 0.24, respectively. The importance of “leadership importance” concerning “class cohesion,” “cooperation among students,” “students’ mood in class,” “student differences,” and “students’ attitudes toward learning” was 0.53, 0.24, 0.63, 0.56, and 0.65, respectively. “leadership” is only less important than “cooperation among students”. The importance of “class cohesion” and “student differences” is comparable to that of “leadership importance”, while “leadership importance” The importance of “leadership” was slightly more important than “students’ mood in class” and “students’ attitudes toward learning”. After consistency transformation and hierarchical ranking, it can be seen that for the organizational leadership index level, the weighting of the influencing factors governing the sports season is cooperation among students, leadership importance, class cohesion, student differences, students’ mood in class, and students’ learning attitudes, with the weights of 0.2, 0.19, 0.17, 0.16, 0.14, and 0.13, respectively.

Figure 3. The importance of each metric of the hardware teaching indicator layer
4.2.2 Teaching classroom indicator layer analysis

The importance scores of each constraint in the teaching classroom index level are shown in Table 7. Comparing the importance of different conditions, the score of “students’ interest in physical education” compared with “teachers’ teaching attitude” is 0.36, which means that the latter is slightly more important than the former. The importance of “students’ interest in physical education” compared to “teachers’ teaching level” was 0.22, indicating that the latter was significantly more important than the former. The importance rating of “students’ interest in physical education” compared to “classroom atmosphere” was 0.42, indicating that the latter was slightly more important than the former. The importance of “students’ interest in physical education” compared to “teacher-student relationship” was 0.51, which indicates that both are equally important. The importance rating of “students’ interest in physical education” compared with “physical education philosophy” was 0.86, indicating that the former was more important than the latter. After consistency transformation and hierarchical ranking, it can be seen that for the classroom index level, the weighting of the influencing factors governing the sports season was the teacher’s teaching level, teacher’s teaching attitude, classroom cohesion, classroom atmosphere, teacher-student relationship, and physical education philosophy, with the weights of 0.27, 0.24, 0.18, 0.15, 0.11, and 0.06, respectively.

Table 7. Significance scores for constraints at the teaching level

<table>
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<tr>
<th>Importance</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
<th>S11</th>
<th>S12</th>
</tr>
</thead>
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<td>0.36</td>
<td>0.22</td>
<td>0.42</td>
<td>0.51</td>
<td>0.86</td>
</tr>
<tr>
<td>S8</td>
<td>0.64</td>
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<td>0.22</td>
<td>0.44</td>
<td>0.51</td>
<td>0.86</td>
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<tr>
<td>S9</td>
<td>0.78</td>
<td>0.84</td>
<td>0.5</td>
<td>0.44</td>
<td>0.51</td>
<td>0.86</td>
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<tr>
<td>S10</td>
<td>0.58</td>
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<td>0.8</td>
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<td>0.51</td>
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</tr>
<tr>
<td>S11</td>
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<td>0.37</td>
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<tr>
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<td>0.13</td>
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</table>
5 Conclusion

In this paper, the existing constraints of the sports season teaching mode in college physical education are studied based on fuzzy hierarchical analysis. The constraints’ influence weights are analyzed from the hardware teaching environment and the software teaching environment. The top three constraints for the hardware teaching environment are sports facilities, sports venues, and teacher-student ratio in order. For the software teaching environment, the top three constraints in the organizational leadership dimension are cooperation among students, leadership importance, and class cohesion, and the maximum three constraints in the teaching classroom dimension are teachers’ teaching level, teachers’ teaching attitude, and class cohesion in that order. As a result, the following aspects of sports season teaching can be carried out in universities:

1) Expand the scope of the study to include a school-wide sports season model of instruction in the physical education curriculum.

2) Set up a rich and diverse selection of courses, and students can select classes across grades in the whole school.

3) Implementing small classes during the teaching schedule and large courses outside the classroom during the optional time.

4) Improve theoretical design, increase experimental samples, and improve data analysis methods, especially strengthening empirical research on athletic ability, MVPA, physical fitness, and learning attitudes.

References


